MIPP-NOTE-SIM-71

Vertex resolution of two particle proton-Carbon events

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1 Introduction

I attempt to estimate the vertex resolution that we could hope to get for events where final state has only two charged particles at the primary vertex. I used Fluka as the particle production model.

If I take two lines,

$$\begin{aligned} x &= z\tan\theta_1 + b_1 \\ x &= z\tan\theta_2 + b_2, \end{aligned}$$

where θ_1 and θ_2 are the angles of each secondary track with respect to z-axis, then

$$\begin{aligned} x_{vtx} &= \frac{b_1\tan\theta_2 - b_2\tan\theta_1}{\tan\theta_2 - \tan\theta_1} \\ z_{vtx} &= \frac{b_1 - b_2}{\tan\theta_2 - \tan\theta_1} \end{aligned}$$

According to E910 measurements, the resolution in x was 0.6 mm and resolution in y was 0.7 mm. I assume that transverse resolution $\sigma_b \approx 0.65$ mm. Furthermore, we can assume that the error on $\tan\theta$ is small and that $b_1 - b_2 \ll \sigma_b$ (that is vertex is close to $z = 0$), then

$$\sigma_x^2 = \sigma_b^2 \cdot \frac{\tan^2\theta_1 + \tan^2\theta_2}{(\tan\theta_1 - \tan\theta_2)^2}, \quad (1)$$

$$\sigma_z^2 = \sigma_b^2 \cdot \frac{2}{(\tan\theta_1 - \tan\theta_2)^2}. \quad (2)$$

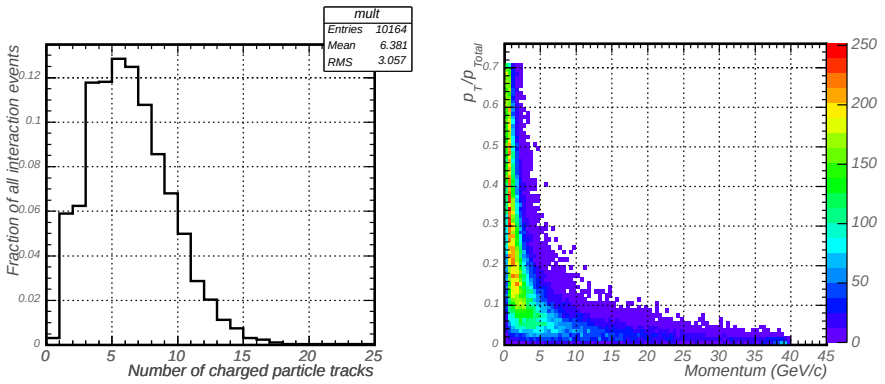

Figure 1: Multiplicity and distribution of transverse momentum versus total momentum of forward-going charged particles

2 Fluka simulation

I used Fluka to generate interactions on carbon with 40 GeV/c protons. Figure 1 shows multiplicity of charged particles with $p_z > 50$ MeV/c and $p_z > p_{\mathrm{T}}$ and distribution of the fraction of transverse momentum to total momentum versus total momentum. The charged particles that were plotted are those that get out of target, i.e. I assume that particles resulting from decays of $\mathrm{K_S}$ and Λ will not be included into calculation of vertex position.

For simplicity, let's assume that the beam track and the two resulting tracks lie in one plane and the angles of the two resulting tracks are opposite. This is the most optimistic estimate. Figure 3 shows the expected vertex resolution.

3 Conclusion

Based on Figure 3, for most two charged particle final state events, we can expect vertex resolution of around 1.5 mm if we can attain transverse resolution of order of 600 micron. This means that with high confidence level we would be able to tell whether event happened in the thin target or in the scintillator located about 1.5 cm downstream of the target. However, the long tail stretching out past 10 mm is worriesome, since for that class of events, we will not be able to tell whether the vertex is in the scintillator or in the target. About 17% of events have vertex resolution larger than 4 mm.

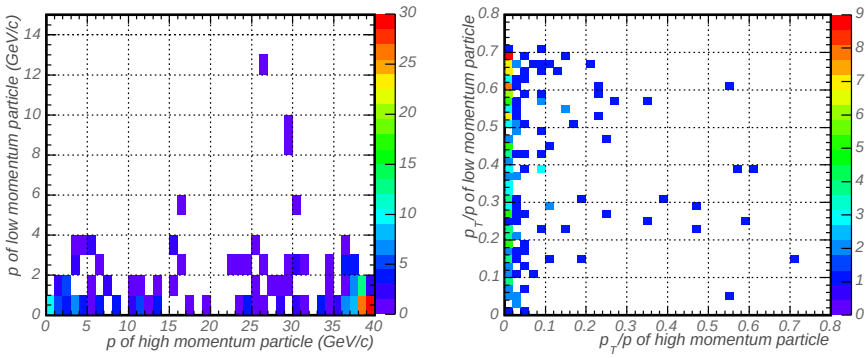

Figure 2: Distribution of momenta and angles of the two particles

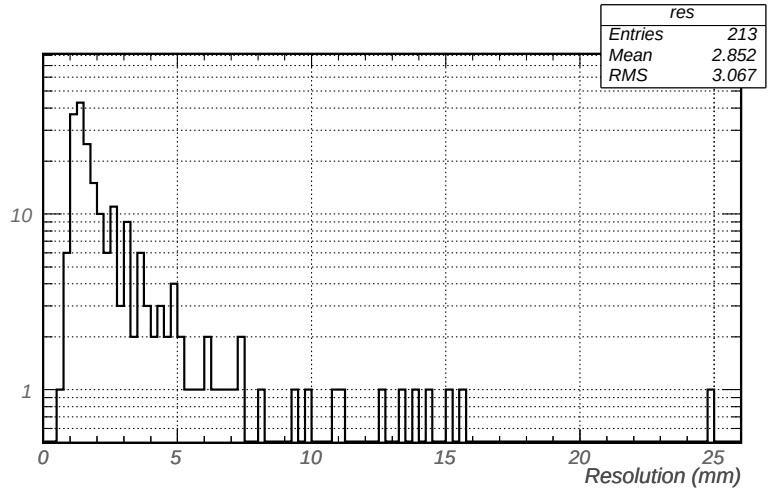

Figure 3: Expected vertex resolution in z for events with two particles in the final state